Concepts and guidelines for diagnostic assessments of agricultural innovation capacity

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CONCEPTS AND GUIDELINES FOR DIAGNOSTIC ASSESSMENTS OF AGRICULTURAL INNOVATION CAPACITY

Andy Hall, Lynn Mytelka and Banji Oyeyinka[1]

Abstract

This paper is divided into two parts. The first part sets out a conceptual framework for diagnostic assessments of agricultural innovation capacity. It explains that contemporary patterns of agricultural development demand fresh thinking on how innovation can be promoted in ways that can deal with rapidly evolving production and market conditions. The innovation systems concept is presented as a framework for examining the notion of innovation capacity. The second part of the paper provides guidance on how the principles of this conceptual framework can be used in diagnostic assessments. These guidelines include a number of typological tools to explore the qualitative aspects of innovation capacity – particularly patterns of interaction and the habits and practices that inform these.

Key words: Public private sector partnerships; innovation systems; institutional change; capacity development; social capital.

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1. INTRODUCTION

This purpose of this paper is to introduce a framework for undertakings diagnostic assessments of innovation capacity in the relation to emerging pattern of agricultural activity in developing countries. The purpose of such diagnostic assessments is to identify intervention points for strengthening innovation capacity. The importance of this is that it marks a departure from the much recent research applying the innovation systems concept where it has been applied to explain historic patterns of economic activity. The framework outlined in this paper is a step towards applying this concept in intervention design.

This paper presents the innovation system concept and provides guidelines on how this can be used for diagnostic assessments – i.e. as a way of explain the short coming of existing innovation capacity and identifying intervention points for capacity development assistance.

The paper is divided into two parts. The first begins by outlining different diagnoses of the problems of agricultural research the conventional policy tool for stimulating agricultural innovation in most countries and in most donor development assistance programmes. It then presents a stylised view of the emerging New Agriculture. This, it is argued, is comprised of knowledge-intensive niche sectors, with strong rates of growth in rapidly evolving market and technological conditions where the creation of dynamic innovation capacities is central to economic success. A detailed discussion of the insights derived from innovation systems concept is then presents. The second part of the paper provides guidance on how the principles of this conceptual framework can be used in diagnostic assessments. These guidelines include a number of typological tools to explore the qualitative aspects of innovation capacity.

PART 1: CONCEPTS FOR DIAGNOSTIC ASSESSMENTS OF AGRICULTURAL INNOVATION CAPACITY

1.1. Innovation and development

Innovation is becoming central to the ability of farmers, agro-enterprises and countries to cope, exploit and compete in rapidly evolving technical and economic conditions. In the agricultural sector there has been a long tradition of development assistance investments in pubic research systems. Yet there is growing recognition that while public agricultural research is necessary, on its own it is not sufficient to create a dynamic innovation capacity. Questions therefore exist both about the nature of complementary interventions that are required to develop this capacity and about the sorts of analytical and policy frameworks that can be used to diagnose existing arrangements and define appropriate remedies. Fresh direction, however, is coming from recent insights that recognise that the innovation process involves not only research, but also a wide range of other activities, actors and relationships associated with the creation and transmission of knowledge and its productive use. As a framework for applying these insights the concept of an innovation system is emerging as a potentially valuable tool to help rethink the role and contribution of agricultural research (Hall et al 2002).

The origin of this framework is the concept of a national system of innovation (Freeman1988, and Lundval 1991). It emerged as a response to the limited explanatory power of conventional economic models that view innovation as a linear process driven by the supply of research and development (R&D). Instead the innovation systems framework conceptualized innovation in more systemic, interactive and evolutionary terms whereby networks of organizations, together with the institutions and policies that affect their innovative behaviour and performance, bring new products, new processes and new forms of organization into economic use (Nelson and Winter 1982, Freeman 1988, Lundval 1992; Edquist 1997). The framework is now being used to understand and strengthen innovation at national, sector levels(OECD, 1997; Mytelka and Goertzen, 2004) including agriculture, (Hall et al 2002).

1.2 Agricultural research and innovation and the New Agriculture

1.2.1 The critique of agricultural research and its contribution to innovation

For some time there has been a recognition that agriculture research efforts in many developing countries are failing to bring about the social and economic transformations to the extent that their potential would suggest. This problem and ways of dealing with it, is discussed in a number of ways.

Ineffective technology transfer. Consistent with the logic of establishing centralised research facilities for the production of knowledge and technology, an early (and persistent critique) has been that technology transfer and diffusion process have been ineffective. But it is clear that while agricultural extension arrangement have been notoriously ineffective, weak technology adoption is not only a supply issue.

Incorrect research priorities. Again consistent with the underlying conceptualisation of a research systems is the charge that research investments need to be prioritized based on the likely economic pay backs of different options. Extensive efforts have been made by many national and international research organisations to set priorities in this, but there is little evidence that this has improved the impact of research.

Weak demand for research products. It gradually became apparent that poor adoption of technology by farmers was perhaps a result of research systems delivering technologies that they has little use for or which did not suit their specific requirements. Various ways of addressing this have been proposed such as better research-extension-farmer linkages, participatory approaches to planning and research. These have had some success but have not addressed the underlying habits and practices of systems where research organisations remain the central sources of knowledge. This tended to make it difficult for other stakeholders (particularly poor ones) to articulate their demands and ensure that their agendas are supported.

Against the backdrop of these critiques agricultural research faces a range of challenges that require institutional change. These are summarised in box 1. What is clear is that the old conceptualisation of research leading to technology and in turn leading to economic production is no longer adequate.

1.2.2 The New Agriculture and challenges of creating dynamic innovation capacity

Part of the problem that agricultural research faces is the fact that the one-size fits all model agricultural research system is simply not suited to the emerging reality of the developing country agricultural sector. While production, sale and consumption of major food crops remains important, a number of niche sectors are emerging with impressive rates of growth and this is couple with fundamental changes in the nature of the sector as whole. These include:

- A much greater role for organisations beyond the State, particularly the private, but also cooperative and civil society sectors.
- The delineation of new and dynamic niche sectors such as export horticulture and agro-processing which are knowledge-intensive; the importance to the poor both as producers and sources of employment; the need compete rapidly evolving international markets; and the need to tailor innovation capacities to these heterogeneous developments.
- The policy recognition of the importance of upgrading and innovation not only in hi-tech sectors, but also traditional sectors including the natural resources and the need to both compete internationally and add or retain value in country.
- Rapidly evolving production, consumption and marketing conditions driven by new technology, globalization, urbanisation and associated phenomenon such as the industrialisation of the food chain and the consequent importance of innovation as a source of competitive advantage in these conditions.

Niche sectors in the New Agriculture are not necessarily going to benefit the poor in the traditional way of providing new opportunities to the poor as framers – although it does not necessarily preclude that. Instead, it will be rural non-farm employment opportunities that will be important. Take for example cut flowers in Keyna. Not only did it achieve an annual growth rate of 20% between 1991 and 2001, the third best foreign exchange earner after tea and tourism, but is highly labour intensive employing 50,000 mainly women workers (Opondo 2003). In Bangladesh small scale food processing is a sector growing at 32% per annum providing employment for both men and women. ITDG (2004) estimate that in a Bangladeshi town of 40,000 the annual turn over of the street food industry is US$ 2 million. The aquaculture industry, which has grown very rapidly in many Asian countries has also shown impressive rates of growth. In the 1980s' while the number of people employed in agriculture grew by 15% the number of people employed in the fisheries sector grew by 72%.

The reality of the New Agriculture is characterised by the emergence of new players, needing to respond rapidly to changing conditions, often in increasingly knowledge intensive sectors. While traditional agricultural research organisations still have a role to play in providing some of this knowledge, what is now required is a much more flexible arrangement in which dense

networks of entrepreneurs, farmers, research and training and policy organisations interact and response to new circumstances. It is here that the innovation system concept has something new to offer thinking on how to create the dynamic innovation capacities that farmers firms and countries need in order to survive and grow in this environment.

Box 1. The Challenges for Agricultural Research

- The growing realisation that old the National Agricultural Research System model is obsolete as a organisational focus for capacity development, and that while financial resources have declined many of the constraints faced by research systems are institutional in nature (Byerlee and Alex, 1998)
- The increasing demands for more pluralistic arrangements for funding and execution of agricultural research, with a greater role envisaged for the private sector.(Pray and Umali-Deninger, 1998; Echerreviar 1998)and the challenges this presents Byerlee and Echerreviar 2002; Spielman and von Grebmer , 2004)
- A recognition that civil society organisations and other non-research organisations, including farmers, have an important role to play in innovation and that rather than just acting as conduits for technology, they have a more important role, often innovating with alternative modes of practice. (Biggs and Clay 1981 ; Biggs 1990; Clark et al 2003, Prasad 2004)
- Changing paradigms in developments practice where participation, diversity, and self reflection are becoming the expected modes of professional behaviour (Chambers 1983, Watts et al 2003)
- The broadening of the policy agenda of agricultural research to include poverty reduction and environmental sustainability (Hall at al 2000) and the increasing calls for socially responsible research and development interventions (Berdegue and Escobar 2004 ; Biggs and Matsaert 2004).
- Concerns about the impact of agricultural research and worries about economic impact assessment as a way of dealing with this. And the recognition that institutional learning could be an important tool for improving performance (Hall et al 2002, 2003, Horton and Mackay, Watts et al 2003)

Opportunities presented by rapid developments in biotechnology and information technology and new patterns of knowledge ownership particularly in the area of biotechnology (Hall et al, 2004)

- A rapidly evolving development scenario characterized by the poor's changing relationship to agriculture, industrialization of the food chain, rapid urbanization and increasing competitive pressure in global agricultural commodity markets (Ashley and Maxwell, 2001)

1.3. The innovation system framework

1.3.1 Origins and context

Before looking at the innovation systems framework in detail it is useful to start by revisiting the notion of innovation as the importance of innovation , and its contrast to invention, is a central to the reconceptulisation of the relationship of science and technology and economic change. It is also important to be aware that the origins of the debates about innovation and innovation systems have emerged in relation to understanding the behaviour of firms in developed economies. This is useful for the discussion about contemporary agricultural sectors in developing countries were the private sector is becoming a much more important player. However one needs to be sensitive to the fact that the organisational focus of innovation activities does not map exactly onto the developing country agriculture scenario. Yet, as shall be demonstrated, the value of the framework is the underpinning logic it provides about how innovation can be promoted, rather than a checklist of the types of organisation that should be present. To make the same point differently the innovation systems framework allows the roles and relationships of different actors and organisations to be explored and this is important at a time when, as is the case in developing country agriculture, new actors are emerging and roles of existing ones are changing.

1.3.2 On innovation

As opposed to the focus on novelty that is central to the concept of invention, innovation is the process by which organisation "master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors, their country or the world" (Mytelka 2000). Innovation can comprise both radical but usually many small improvements .

Innovation can be triggered in many ways. Bottlenecks in production within a firm, changes in technology, competitive conditions, international trade rules or domestic regulations, environmental health and even wars have been known to stimulate a process of innovation (Rosenberg, 1976; Dosi, 1988; Chandler 1990; Nelson 1996). During the 1970's and 1980's production became more knowledge-intensive as investments in intangibles such as research and development, software, design, engineering, training, marketing and management, came to play a greater role in the production of goods and services. Much of this involved tacit knowledge rather than codified knowledge and mastery thus required a conscious effort at learning by doing, by using and by interacting (Mytelka, 1987, 1999).

Gradually the knowledge intensity of production extended beyond the high technology sectors to reshape a broad spectrum of traditional industries from shrimp and salmon fisheries in the Philippines, Norway and Chile, the forestry and flower enterprises in Kenya, the Netherlands and Colombia, to furniture, textiles and garments in Indonesia, Italy and Taiwan.

Within the context of more knowledge-intensive production, firms began to compete not only on price but also on the basis of their ability to innovate. As traditional barriers to trade and investment were dismantled, innovation-based competition diffused around the globe. This put pressure on local firms everywhere to engage in a process of continuous innovation and challenged governments to develop policies to stimulate and support an innovation process.

Conventional economic models that viewed innovation as a linear process driven by the supply of R&D, however, were increasingly subject to criticism for their limited explanatory power and lack of guidance for policy making under these changing technological and competitive conditions. This created the space for the emergence of alternative conceptualisations of the innovation process, notably those that understood innovation in more systemic, interactive, institutional and evolutionary terms. Overtime these 'innovation systems approaches' gained wide support among OECD member countries and more recently have been applied in the European Union and in a number of developing countries as a framework for policy-relevant analysis (OECD, 1997; Wong, 2003; Cassiolato et al 2003)

1.3.3. Reconceptualising innovation in a systems framework

The systems conceptualisation of innovation marks a sharp difference from earlier thinking on innovation as linear process of R&D leading to technical and economic change. An innovation system can be defined as networks of organizations or actors, together with the institutions and policies that affect their innovative behaviour and performance, bring new products, new processes and new forms of organization into economic use. As an evolutionary model, the focus is on interaction between actors and their embeddedness in an institutional and policy context that influences their innovative behaviour and performance.

The scope of potentially important actors in an innovation system also differs from the set of suppliers and clients arranged along the classic value chain or from the set of organisations that are the traditional focus of science and technology studies – public research bodies etc. There is no assumption, moreover that an innovation process is linear or that knowledge outputs feed directly or automatically into new practices, processes or products in the market. Instead, the

knowledge and information flows that are at the core of an innovation system are multidirectional in nature and open opportunities for the development of feedback loops that can enhance competence building, learning and adaptation. All too often, however, the right kinds of actors are not present or do not interact in a way that supports a process of innovation. The innovation systems concept provides a framework that is useful in understanding why.

1.4 Key insights of the innovation systems concept

1.4.1 Focus on innovation

In contrast to most economic frameworks that focus on production (output) the framework's focus is on innovation. This is often confused with research and measured in terms of scientific or technical outputs. However the framework stresses that innovation is neither research nor science and technology, but rather the application of knowledge (of all types) in production to achieve desired social or economic outcomes. This knowledge might be acquired through learning, research or experience, but until applied it can not be considered innovation. While this knowledge can be brand new innovation often involves the reworking of the existing stock of knowledge, making new combinations or new uses (Edquist, 1997).

1.4.2 Linkages, partnerships, networks

These processes of acquiring knowledge and learning are interactive often requiring quite extensive linkages with different knowledge bases. These knowledge-bases may be scientific and technical, but equally they can be a source of other forms of knowledge, both tacit and codified. The types of linkage involved in learning can vary. So for example two or more organisations may decided to learn collaboratively, developing something jointly. This would be a partnership. Alternatively an organisation might simply buy the goods and services of another organisation. These may be knowledge embodied goods such as technologies and protocols, equipment or germplasm. These could be the services of a marketing organisation. This would be a linkage, but not necessarily a partnership and would probably fall under normal contract relations, including purchase of licences from holders of patterns. There may be other forms of connections more like a network which an organisation might use to gather market and other early-warning intelligence on changing consumers preferences or technological changes. These networks may also be used to provide access to input and output markets. Finally networks provide the "know who" of knowledge bases that can be turn to when the need arises. All these forms of linkage are important in effective innovation system. But it is important to

recognise the logic of linkages of different types for different purposes rather just pursuing linkage for linkage sake.

1.4.3 New actors, new roles

In the linear view innovation and particular with regards to developing country agriculture, public research and extension agencies where regarded as the prime movers. These roles were fairly compartmentalised - scientists undertook research, extension services transferred technology. And, these roles remained relatively static even though the external environment was changing - for instance farmers needed assistance with accessing new markets not just new technology. The innovation systems framework recognises that i) a broad spectrum of actors outside the State have an important role; ii) the relative importance of different actors changes during the innovation process; iii) as circumstances change and as actors learn, roles can evolve; and iv) actors can play multiple roles - sometimes as a source of knowledge, sometimes as a seeker of knowledge, sometimes as a coordinator of linkages between others (Hall 2004, Mytelka 2004)

1.4.4 The role of institutions

Institutional settings play a central role in shaping the processes critical to innovation - linking or interacting, learning, knowledge flows and investment. Again the meaning of institutions is often confused. The framework distinguishes institutions from organisations – i.e. enterprises, research institutes, farmer cooperatives, non-government organisations. Institutions on the other hand are understood as the sets of common habits, routines practices, rules or laws that regulate the relations and interactions between individuals and groups (Edquist, 1997). It is these habits and practices that determine the propensity of actors and organisations to innovate: for instance do they have a tradition of interacting with other organisations or do they tend to work in isolation. Do they have a tradition of sharing information with collaborators and competitors, of learning and upgrading, or are they more conservative. What is their attitude to risk taking? This is important as innovation often requires investment (in training, in equipment, in marketing) and this involves a degree of risk taking. Habits and practices also determine the way organisations respond to innovation triggers such as policy changes, or changing market and technological conditions. Because habits and practices vary across organisations and across countries and regions, there is no certainty about the way actors in innovation systems will respond. For this reason the embeddedness of innovation process in institutional contexts has to be accounted for in innovation capacity development interventions and this will often involve tackling some of these habits and practices and tailoring policies and incentives accordingly.

1.4.5 The role of policies

Policies are also important in determining how actors behave. However policy support of innovation is not the outcome of a single policy but a set of policies that work together to shape innovative behaviour. This means that there is a need to be sensitive to the wide range of policies that affect innovation and seeks ways co-ordinate these. Furthermore, habits and practices -- institutions -- interact with polices and so to design effective policies it is necessary to take into account the habits and practice of actors (Mytelka, 2000). So, for example, the introduction of more participatory approaches to research is often ineffective unless the habits and practices (and incentives) of scientist are also changed. An other example is food safety regulations which might be rendered ineffective in cases where agencies to enforce these have a tradition of rent seeking behaviour. Again this reflects the embedded and contextual nature of the innovation process and the fact that policies to promote have to be sensitive to specific contexts.

1.4.6 *Inclusion of stakeholders and the demand side*

The framework stress the importance of being inclusive of stakeholders and of developing the habits and practices that make organisations and polices sensitive to the agendas or demands of stakeholders. Demand is amongst the signals that shape the focus of and direction of the innovation. It is not just articulated by the market, but can take place through a variety non-market mediated ways such as collaborative relationships between users and producers of knowledge. Policy can also be used to stimulate demand for certain sorts of innovation, by for instance providing incentives. This can be is important where key stakeholders are poor and have limited social and economic leverage or where environmental externalities need to be addressed.

1.4.7 *The dynamic nature of innovation systems*

The habits and practices so critical to innovation are themselves learnt behaviours which shape approaches and arrangements and which are continuously changing in both incremental and radical ways. These changes include institutional innovations, such as farmer field schools or participatory plant breeding, that emerge through scientists' experimentation and learning. These new approaches often not only require new ways of working, but also require new partners.

1.4.8 Co-evolution of contexts and connections

This need to reconfigure linkages or networks of partners is the classic response of more successful innovation systems in the face of external shocks (Mytelka and Farinelli 2003). This

might be a new pest problem requiring new alliances between different scientific disciplines; a new technology such as biotechnology raising the need to form partnerships between the public and private sectors; or changing trade rules and competitive pressure in international markets requiring new alliances both between local companies and with research organisations. It is not possible to be prescriptive about the types of networks, linkages and partnerships that, for example, agricultural research organisations will need to have in the future as the nature of future shocks and triggers is unknown and to a large extent unknowable. However one way of dealing with this is to develop the habits and institutions that allow dynamic and rapid responses to changing circumstances. This might involve confidence building measures that build up trust. But also other measures that strengthen preparedness for change and stimulate creativity and the ability to reconfigure.

To conclude this introduction to innovation systems Table 1 presents the differences and similarities between an agricultural research system and an agricultural innovation system. It should also be clarified at this point that the agricultural innovation system concept is not presented here as a something that should take on administrative and bureaucratic form – although it does have implications for existing bureaucracies. It is not being suggested that a national agricultural innovation system organisation or council is established – although coordination is clearly an element of the capacity to innovate. The concept is being presented as a policy tool, i.e. as a way of organising thinking on the analysis and understanding of how innovation can be nurtured, how appropriate capacities can be built and how social and economic change can be accelerated.

Table 1. Similarities and difference between agricultural research systems and agricultural innovation systems in developing countries

Institutional features	Agricultural research systems	Agricultural innovation systems
Guiding agenda	Scientific	Sustainable and equitable developmental
Role of actors	As researchers only	Multiple and evolving
Relationships involved	Narrow, hierarchical	Diverse, interactive
Partners	Scientists in agricultural research organisations and other public agencies such as universities	Evolving coalitions of interest. Various combinations of scientist, entrepreneurs, farmer and development workers from the public and private sectors
Policy focus	**Narrow** related to agricultural research and agriculture and food policy. **Disconnected** from other policy domains	**Broad** also inclusive of trade, rural development, industry, environment, education **Integration and coordination** between many policy domains
Policy process	**Disconnected** from actors and knowledge in research system	**Integrated** with actors and knowledge and sensitive to agendas in innovation system
Knowledge produced	Codified Technical/scientific	All forms of codified and tacit knowledge: Scientific, technical, organisational, institutional, marketing and managerial
Indicators of performance	• **Short term:** scientific publications, technologies and patents • **Long term**: patterns of technology adoption	**Short term:** institutional development and change / new behaviours, habits and practices/ patterns of linkage **Long term:** social and economic transformation
Responsibility for achieving impact	Other agencies dedicated to extension and technology promotion	All partners in innovation systems
Capacity development	Trained scientists and research infrastructure	• Training and infrastructure development related to a range of research and economic activities and people. • Policies, practices and institutions that that encourage knowledge flows, learning and innovation among actors in innovation system.

PART 2: GUIDELINES FOR DIAGNOSTIC ASSESSMENTS OF AGRICULTURAL INNOVATION CAPACITY

The earlier section explained that framework can help identify the types of actor and the types of interaction needed to bring about innovation; and that it can identify and design the types of habits, institutions, policies and other interventions that can create this pattern of interaction and linkage in dynamic environments. This section presents an outline of the key elements to be explored in an assessment of agricultural innovation capacity. The approach combines the use of secondary sources of information and interviews to develop an understanding of historical patterns of development in order to provide context to an assessment of the current situation and the challenges being faced. The approach outlined here is tailored to a rapid methodology that could by used by a non-expert in combination with limited training and which would lead to the identification of plausible intervention points for national governments and development assistance agencies. The scope of this approach would not include a systemic survey of actors in the sector, although the guidelines below and the checklists of questions includes sets the parameters for the subsequent design of a survey instrument if this was found to be necessary.

2.1. Sector timeline and evolution

Central message or diagnosis from this section. What is the nature and dynamics of the sector? Who are the main players? What has been the performance of the sector to date. What challenges does the sector face? How effective have policies and support structures been in triggering innovation and developing a dynamic innovation capacity?

Framework

New sectors or clusters of activity are usually triggered by one or a combination of things. This maybe policy or market changes or it may be the result of the intervention of an international development organisation or an international corporation. There are many different types of trigger and these present different context which policies supporting innovation have to deal with. It is therefore important to understand these triggers. The may also have been a series of turning points in the lifecycle of the sector.

It is important to understand this historical pattern of development as it is usually the case that current patterns of activities, roles and relationships have developed incrementally overtime and can not be fully understood without a historical perspective and an understanding of the local policy and institutional context that has shaped this. It is also important to highlight that these are evolving, dynamic sectors and that innovation capacities must be able to support that evolution. Take for example the cut flower industry in Kenya. Many producers actually started out producing green bean for the European market, but then switched to cut flowers. It is important to understand why they had to switch and what were the resources, linkages and capabilities that allowed then to do this and how these response related to local contextual conditions, particularly institutional and policy setting.

Key questions for this section will include.

i) When did the sector start to develop? What were the factors that triggered its emergence? Were these technical, policy or market or other triggers? For example changes in trade rule, the opening up of new markets.

ii) Who were the main players who initiated this and what were their characteristics – public, private, elite groups of farmers, local or foreign companies, international development agencies?

iii) How has the sector grown and evolved over time? Have there been any major market, technology or policy changes that have caused it to evolve in new ways? What were the turning points along the way? For example, the switch from one crop or product to another, or the switch from domestic to international markets?

iv) What other dynamics took place in the sector? For instance, falling world commodity prices, or the entry of new competing countries? Were there changing patterns of linkage or capability in the sector to cope with these dynamics? Or were there features of dynamics in the sector that set up distortion that organisations couldn't cope with leading to exit, decline or alternative paths.

Sector statistics include: value, size, growth rate, employment potential, nature of domestic and international market

Sources of information and methods of data collection.

Secondary documentation. Sector investment reviews. Earlier studies that have explored science, technology and innovation policy issues in the sector. Interviews with key informant / sector specialist in country, but important to triangulate and aware of the possibility of competing or alternative of how the sector evolved and what was important in this process.

2.2. Sector mapping

Central message and diagnosis from this section

Who are the main actors and organisations in the sector, what role do they play and what are their skills and competencies. Which actors and competencies are missing are policy required to change the role of the public sector or to encourage others to play different roles or play existing roles more effectively. What is the extent of linkage between actors and organisations, what is the nature of these links and does it support interaction and learning. Which links are missing links are missing and what types of linkage need to be encouraged.

Framework

At the heart of the innovation systems concept is the question of which actors are involved, the nature and intensity of their interaction and the role that they play in the system. This is particularly important in relation to recent developments in the agricultural sector as private and other actors beyond the State are emerging as a important players and public research organisations need to reconfigure their roles and relationships in the light of these developments.

From the innovation systems perspective it is also important not just to identify links (or missing links) but to unpack these linkages and see which are working well. Are mango exporters just buying expert services from the local university? Is that sufficient to continuously improve quality and innovate with new packaging or products? Do the scientists listen to the problem of the exporter or do they just lecture them? Does their advice have any value? How can relationships be improved.

The task of undertaking this mapping can be split up into several parts:

Existence of relevant organisations:

A useful way to identify organisations relevant to a sector is to use Arnold and Bell's typology of actors in an innovation system (see figure 2). This typology has five broad classifications.

- **The research domain:** this primary involves formal research organisations producing mainly codified knowledge, mainly in the public sector, but recognises that the private sector and NGO's call also have a role.
- **The enterprise domain.** This primarily involves firms and farmers and mainly involves using codified and tacit knowledge and producing tacit knowledge.
- **The demand domain.** This primarily involves consumers and domestic and international markets for products. It also includes policy actors while these are not

consumers in the conventional sense. however they have a demand for knowledge and information produced by the innovation systems (to inform policy) and need to be thought of as an integrated part of the systems in just the same way as consumers of more conventional products.

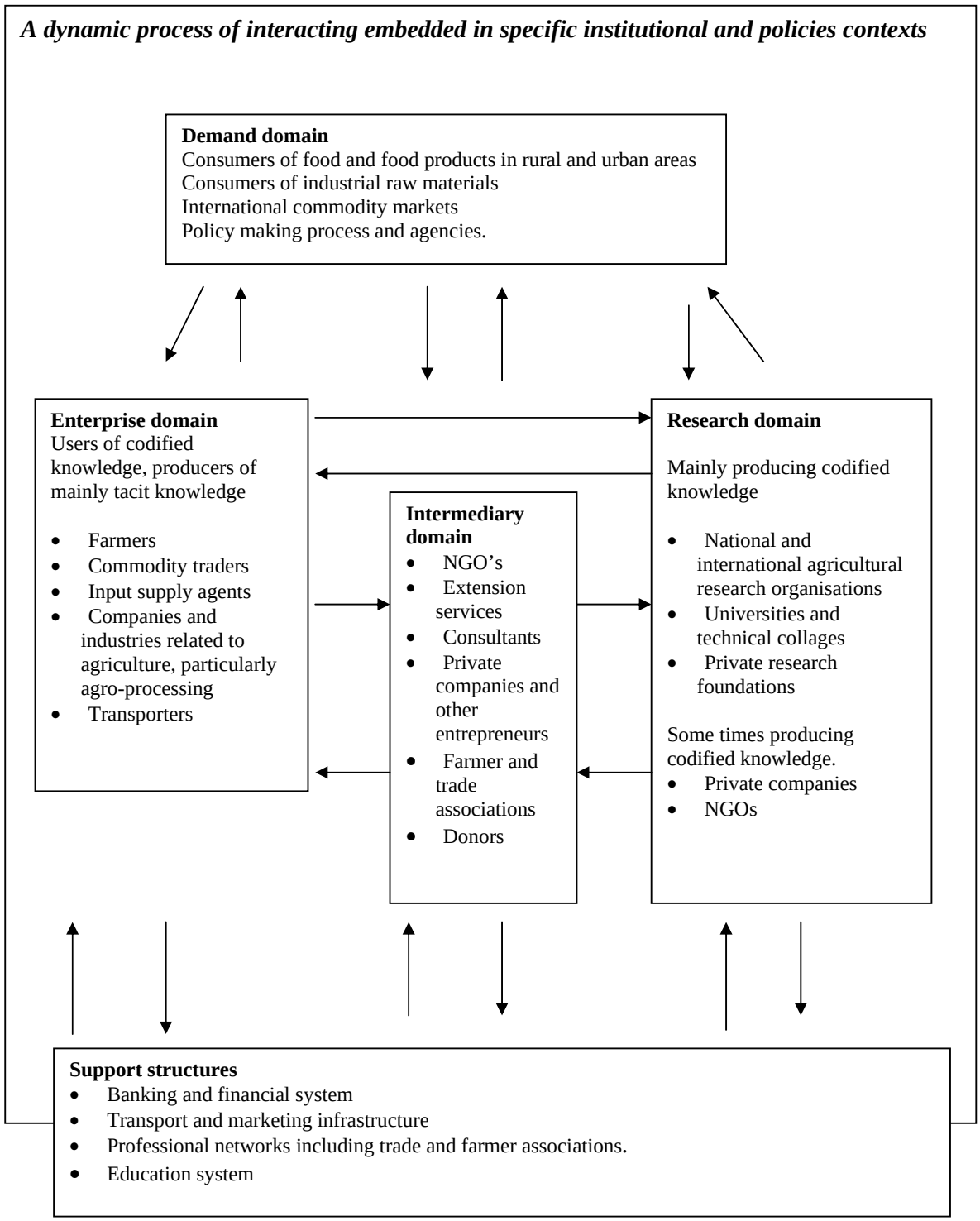
- **The intermediary domain.** Organisations in this domain may not necessarily be involved in creating or using knowledge, but they play a critical role in ensuring knowledge flows form one part of the systems to an other. This might involve articulating demand for knowledge or products from disadvantaged or fragmented constituencies such as framers. This would include NGO, cooperatives, industry associations. Alternatively it might be organisations that make a business out of brokering access to knowledge. These might be consulting companies, or third party agencies such as those trying to provide developing countries with access to biotechnology.

This typology is far from perfect. The categories are not mutually exclusive. Actors can play multiple roles and these roles can evolve over time (see below). Never the less it provides simple guidance on the sorts of organisation that are likely to be important in a sectoral innovation system. By identifying the range of organisations relevant to innovation in the sector, this initial exercise helps identify the organisations that it will be useful to interview in more detail. These interviews will iterate with the mapping exercise.

Sources of information

Sector investment reviews. Earlier studies that have explored science, technology and innovation policy issues in the sector. Interviews with key informant / sector specialist in country

Elements of an agricultural innovation system



Adapted from *Some New Ideas About Research for Development*, by Erik Arnold and Martin Bell in Danish Ministry of Foreign Affairs: **Partnership at the Leading Edge: A Danish Vision for Knowledge, Research and Development** (April 2001).page 279

2.2.2 Extent of competency of existing organisations

Even within the categories of organisation discussed above there will be great heterogeneity. It is important to get some understanding of the competencies that currently exist within these organisations as this will provide insights into their underlying skills and the extent to which these can support problem solving, creativity and innovation. These capacities will include number of scientists, mangers, marketing experts and their qualifications and skills. The types of competencies to be investigated will be dependant on the nature of the organisation, for instance:

Research organisations

Enterprise organisations

Intermediary organisations

Demand organisations

Sources of information

Secondary sources, particularly annual reports where available. A systematic sector survey is beyond the scope of this study, instead these questions should form part of a checklist used in face to face interviews with key sector informants. Selection of informants will ensure that the different categories of organisation are adequately covered.

Role of different actors

One of the features of effective innovation systems is the way organisations beyond the State are playing a pro-active role in the creation and development of opportunities. In addition role flexibility is also important as highly compartmentalised and rigidly defined roles do not allow organisation to reconfigure and respond flexibly to changing circumstances. So for example if the private seed companies emerge as a major source of plant breeding expertise, should the public sector continue to play this role or should to adapt and find a new strategic role. If the NGO sector is the major driver of rural development activities what role should the public sector play? Is the public sector concentrating too much on technology development and not enough on its role in providing supporting structures for innovation such as credit and training?

Important questions include:

Who is the sector champion? Are they from the public or private sectors? What role are farmers and other sector organisation playing in planning and policy? To what extent is there role compartmentalisation in relevant public agencies? How rigid is their mandate? Has this evolved to deal with contemporary development questions? Have reforms defined new roles which have not actually been adopted by these agencies. Are intermediary organisation beyond the State

starting to emerge in importance and how are public agencies and public policy trying to deal with this.

2.2.3 Existence and nature of linkages between organisations relevant to innovation in the sector

Interactions between different actors and organisations are central to effective innovation systems. To understand patterns of interaction it is first important to map linkages in a general ways, but then it is also necessary to understand the nature and purpose of these linkages. Two tools are useful here. The first is an actor linkage matrix which allows the extent of links to be systematically investigated. This is often more useful than a diagram with arrows are these can become too complex and unwieldy. In the actor linkage matrix, all relevant actors in the sector innovation system (identified above) on both the first row and first column of the matrix. Each box in the matrix then represents the linkage between two actors or organisations. It is important to be specific and mention a particular company, or a farmers organisation or research institute, rather than try to map linkages between different categories. The example in table shows that while there are extensive linkages, the sorts of linkage that support interactive learning and innovation are absent.

Matrix of linkages

Table 2 Example of actor matrix

	Crop research institute	Vijay Mango Exports Pvt	Krishna farmers association	Krishna market commission agents
Crop research institute		Knowledge services contract	Paternalistic	Nil
Vijay Mango Exports Pvt			Input supply links	Input supply links
Krishna farmers association				Output market links
Krishna market commission agents				

The second tool is a typology of linkages that includes both the type of link and the purpose of linkage. This is important as it helps distinguish between the links an organisation might have with an input supplier (important though these are) and on the other hand the links an organisation may have for the purposes of accessing a technology or collaborating on a joint project which would clearly more important for learning and innovation. This way of classifying linkages helps identify the sorts of linkages that might need to be developed to allow

a continuous process of innovation to take place. Of the six types of linkage discussed all maybe important in an innovation systems at different points in time. More important is to make sure that the right types of linkages exist in the right place. Paternalistic linkages will be of little value where interactive learning and problem solving are required. Successful innovation systems tend to have linkages that support interactive relationships.

It is also useful to classify linkages by the types of learning that they support. The innovation system recognises that learning can take a number of forms: learning by interacting, learning by doing, and learning by imitating (in order to master process or technology), learning by searching (for sources of information) and learning by training. Again, while all of these forms of learning are important, successful innovation systems are characterised by a high degree of interactive learning.

Table 3 A typology of partnerships and learning

Types of linkage	Purpose	Type of learning
Partnership	Joint problem solving, learning and innovation, may involve a formal contract or memorandum of understanding. Maybe less formal, such as participatory research. Highly interactive. May involve two organisation or more. Focused objective defined project	Mainly learning by interacting. Also learning by imitating and learning by searching
Paternalistic	Delivery of goods, services and knowledge to consumers with little regard to their preferences and agendas.	Learning by training
Contract purchase of technology or knowledge services	Learning or problem solving by buying knowledge from else where. Governed by a formal contract. Interactive according to client contractor relations. Usually bilateral arrangement. Highly focused objective defined by contract concerning access to goods and services.	Learning by imitating and mastering Might involve learning by training
Networks	Maybe an informal or formal, but the main objective is to facilitate information flows. Provides know who and early warning information of market, technology and policy changes. Also builds social capital, confidence and trust and creates preparedness for change, lowering barriers to forming new linkages. Board objective	Learning by interacting Learning searching
Advocacy linkages to policy process	Specific links through networks and sector association to inform and influence policy.	Interactive learning
Alliance	Collaboration in the marketing of products, sharing customer bases, sharing of marketing infrastructure. Usually	Learning by doing

	governed by a memorandum of understanding. Can involve one or more organisation. Board collaborative objective.	
Linkages to supply and input and output markets	Mainly informal but also formal arrangements connecting organisations to raw materials, inputs and output markets. Includes access to credit and grants from national and international bodies. Narrow objective of access to goods.	Limited opportunities for learning Some learning by interacting

2.3 Habits and practices of organisations

Central message and diagnosis from this section

What habits and practices do organisation have which restrict, interacting, knowledge sharing, learning, investing and inclusiveness of the demand side. What types of habits and practices should be developed and in which organisations. Are they policies that designed to support innovation that are being negated by existing habits and practices. What measures could be put in place to account for this?

Framework

The habits and practices – institutions -- of organisations in an innovation system are one the defining factors determining the propensity to continuously innovation. Institutions affect innovation in a number of ways. There are those institutions that affect the critical processes of interacting, knowledge sharing and learning. There are those institutions that affect risk taking and which determine whether an organisation will invest in training, new equipment or technology that will be needed to innovate. And there are those institutions that that govern the inclusiveness of organisations and systems of the agenda of all relevant stakeholders, but particularly poor ones. Inclusiveness is important to innovation because it is often a source of demand and non-market mechanisms such as collaboration and linkage are important even where market mechanism are developed.

These sorts of institution can be very subtle. Its often useful to think about broad habits first. So for example is there a traditions of organisations from the private sector working with the public sector? Or of research organisations working with enterprise or civil society organisations? What has characterised the relationship between sectors? Mistrust? Competition? Apprehension? Distain? Relationships within groups of similar organisations also need to be understood. For example is there a tradition of small scale agro-processors working collectively and sharing information. Is the competition for donor funds so intense that NGOs compete with each other rather than collaborate?

Within organisations it is useful to explore how organisation interact with others. Using the typology above what sort of linkages do they mainly have? Is there a tradition of actively seeking new links and partners? Or is the partnership base static? This is important because it determines an organisations ability to reconfigure linkages in the face of changing circumstances. Its part of the dynamic capability to innovate. Is the culture of the organisation participatory and inclusive or is it elitist and top down? How does the organisation treat failure? As a learning opportunity or as something to be covered up? Is the organisation very hierarchical, as this can stifle creativity and lesson learning at lower levels or at least these are not noticed or accepted at higher levels where decisions are made.

Are there any specific habits and practices that increase the intensity and quality of interaction with particular stakeholders or client groups, particularly poor ones. In research organisations this might involve participatory approaches, joint evaluation teams. For companies it might mean in addition to the above, adopting specific policies to source produce from poorer producers, employ particular social groups. For policy bodies it might mean commissioning studies to find out about the agendas of the poor so that this can be factored into policy formulation.

Understanding how the habit and practices of an organisation affect risk taking can also be difficult. Long established family businesses that have followed the same line of business for many are probably less likely to take risk. Strong hierarchies in public organisations tend to stifle risk taking. Professional incentives such as criteria for promotion can also affect risk taking. It is important to recognise the existence of these sorts of habits and practices as cushioning policies can then be devised make to account for these and make it easier for organisation to respond to other incentives, polices and stimuli to invest, interact or be inclusive. Table presents a typology of the sorts of habits and practices that can affect i) interacting, knowledge flows and learning, ii) investing, iii) inclusiveness of poor stakeholder and the demand side.

Sources of information.

Unless specific studies have been undertaken exploring the habits and practices of different organisations secondary sources of information are often quite limited. Face to face interviews are therefore very important for understanding habits and practices. It is useful to remember that because most organisation in a particular country and sector have been shaped by the same historical, cultural and political setting habits and practices in the same category of organisation will be fairly similar. Science in one public research organisation will have similar habits and

practices to those in another organisation in the same research system. Equally there will be similarities among, for instance, feed milling companies. While it is dangerous to over generalise broad patterns of habits and practices can be found from a limited interviews with key informants.

Table 4 Typology of habits and practices affecting key innovation processes and relationships

Innovation processes and relationships	Restrictive habits and practices	Supportive habits and practices
Interacting, knowledge flows, learning	Mistrust of other organisations Closed to others ideas Secretiveness Lack of confidence Professional hierarchies between, organisations and disciples. Internal hierarchies. Top down cultures and approaches Covering up of failures. Limited scope and intensity of interaction in sector networks	Trust Openness Transparency Confidence Mutual respect Flat management structure Reflection and learning from successes and failures. Pro-active networking
Inclusiveness of poor stakeholders and the demand side	Hierarchies Top down cultures and approaches	Consultative and participatory habits
Risk taking and investing	Conservative	Confidence Professional incentives

2.4 Wider policy and support structures

Central message and diagnosis from this section
What are the set of policies that put in place to encourage innovation. Which ones are having a positive impact on the behaviour of actors and organisations and which one are not. Are there contradictory policies that are counteracting each other. Are some of the polices that are not working being affected by habit, practices and institutions of actors and organisations and what additional measures or incentives would be need to account for this. Similarly are support structures effective and if not how do they need to be adpted.

Framework

Policies can stimulate innovation by providing the right incentives, resources (including new knowledge from research) and support structures (education, financial system, labour policies). However policies have to be co-ordinated – there is no one innovation policy, but a set of policy

that work together to shape innovation. Policies must also be relevant to the local context and the habits and practices of the actors whose behaviour the policies are designed to influence.

In doing an analysis of the of an agricultural innovation system it is necessary to examine the the impact on farmers and others actors of polices that directly affect the agricultural sector (agricultural research and extension arrangements), as well as of policies that are designed to affect the inputs to the sector (industrial policies and education polices), the incentives to producers and to companies (tax policies, land use polices, transport policies, tariff policies, as well as policies that affect the opportunities for learning and competition in the domestic market (intellectual property rights, foreign investment policies).

Its also important to recognise that policy changes in the global environment will impact on local innovation systems. International market structures, new rules and disciples being negotiated at the WTO and in other bodies will also shape the parameters within which choices about learning, linkage and investment will be made.

It is also important to explore: The nature of the policy process; Linkages between actors in different policy domains relevant to innovation; linkage between policy and practice; the existence of and constraints to policy learning.

Check list of important policies to be considered relevant to the niche sectors in the case studies

Sources of information.
In order to do this analysis it is necessary to both understand what the particular polices are trying to achieve and then look at how well they are performing. So for example a government may have a policy of promoting agricultural education by training more students. But if the students are not trained in ways that suits them to working in private companies or development organisations the policy will have failed because it had not accounted for the habit and practices of academically oriented agricultural universities. Information of this sort needs to be collected form relevant ministries as well as through face to face interviews with key informants.

Conclusion

This paper proposes guidelines for undertaking diagnostic assessments of agricultural innovation capacity. The next challenge is to validate these guidelines empirically, testing whether they can indeed identify appropriate interventions for developing this type of capacity.

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